JEE Main 2020 Paper

Date: 8th January 2020

Time: 02:30 PM – 05:30 PM

Subject: Chemistry

---

1. Correct bond energy order of the following is:
   a. C-Cl > C-Br > C-I > C-F
   b. C-F < C-Cl < C-Br < C-I
   c. C-F > C-Cl > C-Br > C-I
   d. C-I < C-Br < C-F < C-Cl

Answer: c

Solution: In $C-F$ there is 2p-2p overlapping involved, in $C-Cl$ the overlapping involved is 2p-3p whereas for $C-Br$ and $C-I$ the overlappings involved are 2p-4p and 2p-5p, respectively. The bond length for the various type of overlappings can be given as:

2p-2p < 2p-3p < 2p-4p < 2p-5p.

As we know that Bond energy $\alpha \frac{1}{\text{Bond length}}$

The order of bond energy comes out: C-F > C-Cl > C-Br > C-I

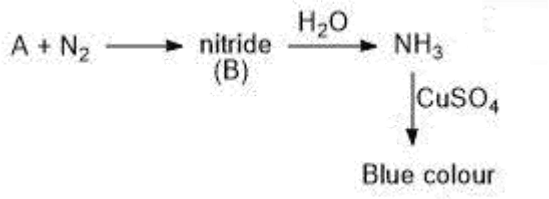
2. Determine Bohr's radius of Li^{2+} ion for n = 2. Given (Bohr's radius of H-atom = a_0)
   a. $\frac{3a_0}{4}$
   b. $\frac{4a_0}{3}$
   c. $\frac{a_0}{3}$
   d. $\frac{16a_0}{9}$

Answer: b

Solution: The formula for Bohr's radius for any unielectronic species is: $r = \frac{a_0 n^2}{z}$

for Li^{2+} : $r = \frac{a_0 2^2}{3} = \frac{4a_0}{3}$

3. Given the following reaction sequence:



A and B are respectively;

a. Mg, Mg_3N_2
b. Na, Na_3N
c. Mg, $Mg(NO_3)_2$
d. Na, $NaNO_3$

Answer: a

Solution: As it is provided in the question that nitride is being formed so the option c and d can be eliminated. Amongst Mg and Na we already know that Mg can only form nitride so the correct choice is option a.

$$3Mg + N_2 \rightarrow Mg_3N_2 \xrightarrow{H_2O} Mg(OH)_2 + NH_3$$

4. Correct order of the magnetic moment(spin only) for the following complexes is:

A. $[Pd(PPh_3)_2Cl_2]$
B. $[Ni(CO)_4]$
C. $[Ni(CN)_4]^{2-}$
D. $[Ni(H_2O)_6]^{2+}$

a. A=B=C<D
b. A<B<C<D
c. A>B>C>D
d. A=B>C>D

Answer: a

Solution: $[Pd(PPh_3)_2Cl_2]$: Here Pd is in +2 oxidation state and configuration of Pd^{2+} is $[Kr]4d^8$. As the CFSE value for Pd is very high so all the electrons will be paired and hence magnetic moment for this complex will be zero.

$[Ni(CO)_4]$: Here Ni is in 0 oxidation state and configuration of Ni is $[Ar]3d^84s^2$. As here the ligand is carbonyl which is a strong field ligand, all the electrons will be paired and hence magnetic moment for this complex will be zero.

$[Ni(CN)_4]^{2-}$: Here Ni is in +2 oxidation state and configuration of Ni^{2+} is $[Ar]3d^8$. As here the ligand is cyanide which is a strong field ligand, all the electrons will be paired and hence magnetic moment for this complex will be zero.

$[Ni(H_2O)_6]^{2+}$: Here Ni is in +2 oxidation state and configuration of Ni^{2+} is $[Ar]3d^8$. As here the ligand is water which is a weak field ligand, the electrons will not be paired and there are two unpaired electrons in this complex hence magnetic moment for this complex will be $\sqrt{8}$ BM.

So the order of magnetic moment is A=B=C<D.

5. Determine the total number of neutrons in three isotopes of hydrogen.

a. 1 b. 2

c. 3 d. 4

Answer: c

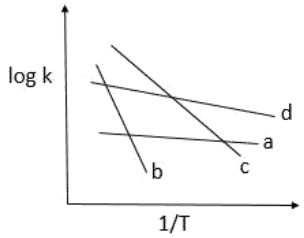
Solution: Number of neutrons in protium $= 0$

Number of neutrons in deuterium $= 1$

Number of neutrons in tritium $= 2$

So, total number of neutrons $= 3$

6.



Compare E_a (activation energy) for a, b, c and d.

a. $E_b > E_c > E_d > E_a$ b. $E_a > E_d > E_c > E_b$

c. $E_c > E_b > E_a > E_d$ d. $E_d > E_a > E_b > E_c$

Answer: a

Solution:

To avoid confusion, in this question we'll be denoting activation energy by E_x

$K = Ae^{-E_x/RT}$

$\log K = \log A - \frac{E_x}{2.303RT}$ -----(1)

Here, the graph given in the question is of a straight line and we know that the equation of straight line is

$y = mx + c$ ----(2)

Comparing equation 1 with 2 we get,

$\text{Slope} = \frac{-E_x}{2.303R}$

So, from the graph we can conclude that the line with the most negative slope will have the maximum activation energy value.

$E_b > E_c > E_d > E_a$

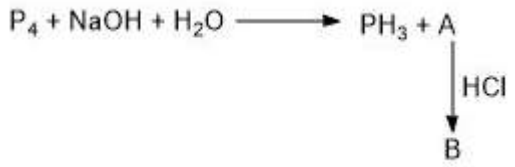
7. Which of the following exhibit both Frenkel and Schottky defect?

a. AgBr
b. KCl
c. CsCl
d. ZnS

Answer: a

Solution: The radius ratio for AgBr is intermediate. Thus, it shows both Frenkel and Schottky defects.

8. Given:



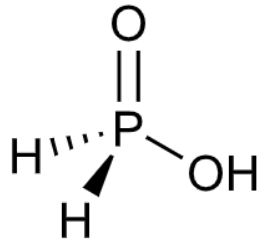
Basicity of B is:

a. 1
b. 2
c. 3
d. 4

Answer: a

Solution: $P_4 + NaOH + H_2O \rightarrow PH_3 + \boxed{NaH_2PO_2 \xrightarrow{HCl} H_3PO_2 + NaCl}$

Here the product B which is mentioned in the question is H_3PO_2. The structure of H_3PO_2 can be given as:



As only 1 Hydrogen atom is attached to the oxygen, its basicity is one.

9. Which reactions do not occurs in the blast furnace in the metallurgy of Fe?

A. $CaO + SiO_2 \rightarrow CaSiO_3$
B. $Fe_2O_3 + CO \rightarrow Fe_3O_4 + CO_2$
C. $FeO + SiO_2 \rightarrow FeSiO_3$
D. $FeO \xrightarrow{\Delta} Fe + \frac{1}{2}O_2$

a. A and B
b. A, B and C
c. C and D
d. A, B, C, D

Answer: c

Solution: In metallurgy of iron, CaO is used as flux which is used to remove the impurities of SiO_2 , $CaO + SiO_2 \rightarrow CaSiO_3$.

Also here Fe_2O_3 is reduced by CO to Fe_3O_4 which is further reduced to FeO which is further reduced to Fe.

$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$

$Fe_3O_4 + CO \rightarrow 3FeO + CO_2$

$FeO + CO \rightarrow Fe + CO_2$

10. Correct order of radius of the elements C, O, F, Cl, Br, is;

a. Br > Cl > C > O > F
b. Br < Cl < C < O <F
c. Cl< C < O < F < Br
d. C > F > O > Br > Cl

Answer: a

Solution:

Across the period size decreases, so the order that follows is: C > O >N> F

Down the group size increases and the order is: Br > Cl > F

Change in size down the group is much more significant as compared to across the period.

So, the overall order of radius of elements is: Br > Cl > C > O > F.

11. Among the following, which will show geometrical isomerism?

A. $[Ni(NH_3)_5Cl]^+$
B. $[Ni(NH_3)_4ClBr]$
C. $[Ni(NH_3)_3Cl]^+$
D. $[Ni(NH_3)_2(NO_2)_2]$

a. B, D
b. A , B
c. A , B and C
d. A, B, C and D

Answer: a

Solution: The complexes of type Ma_4bc and Ma_2b_2 can show geometrical isomerism provided Ma_2b_2 is square planar. The compound given in B is Ma_4bc type and compound in D is Ma_2b_2 type also in D, Ni is surrounded with strong field ligands which will result in dsp^2 hybridisation and hence square planar geometry.

12. **Assertion:** pH of water increases on increasing temperature.

Reason: $H_2O \rightarrow H^+ + OH^-$ is an exothermic process

a. Both assertion and reason are correct and reason is correct explanation of assertion.
b. Both assertion and reason are correct and reason is not correct explanation of assertion.
c. Assertion is true and reason is false.
d. Both assertion and reason are incorrect.

Answer: d

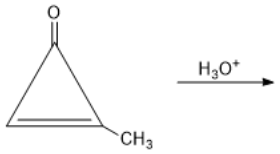
Solution: $H_2O \rightarrow H^+ + OH^-$ is an endothermic process. On increasing the temperature the value of K_w increases which will result in decrease in pK_w . So we can say that pH of water will decrease on increasing temperature because pH for water $=\frac{1}{2} pK_w$.

13. **Assertion:** It has been found that for hydrogenation reaction the catalytic activity increases from group-5 to group-11 metals with maximum activity being shown by group 7-9 elements of the periodic table.
Reason: For 7-9 group elements adsorption rate is maximum.
a. Both assertion and reason are correct and reason is correct explanation of assertion.
b. Both assertion and reason are correct and reason is not correct explanation of assertion.
c. Assertion is true & reason is false.
d. Both are incorrect

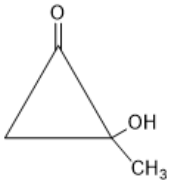
Answer: a

Solution: Group 7-9 elements of the periodic table show variable valencies so they have maximum activity because of the increase in adsorption rate.

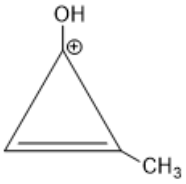
14. The major product of the following reactions is



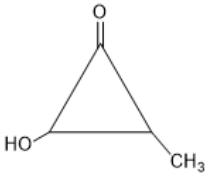
a.



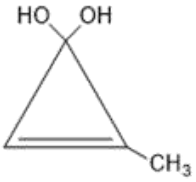
b.



c.

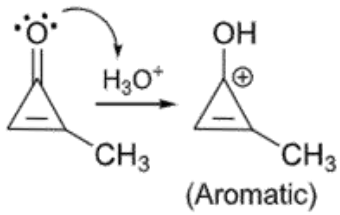


d.

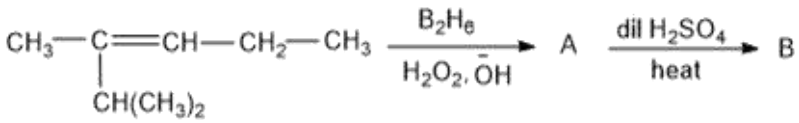


Answer: b

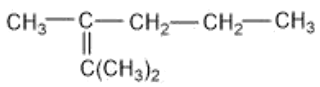
Solution:



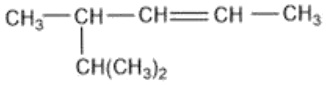
15. Find the final major product of the following reactions?



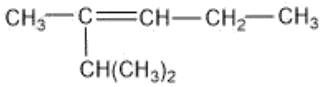
a.



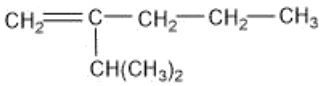
b.



c.

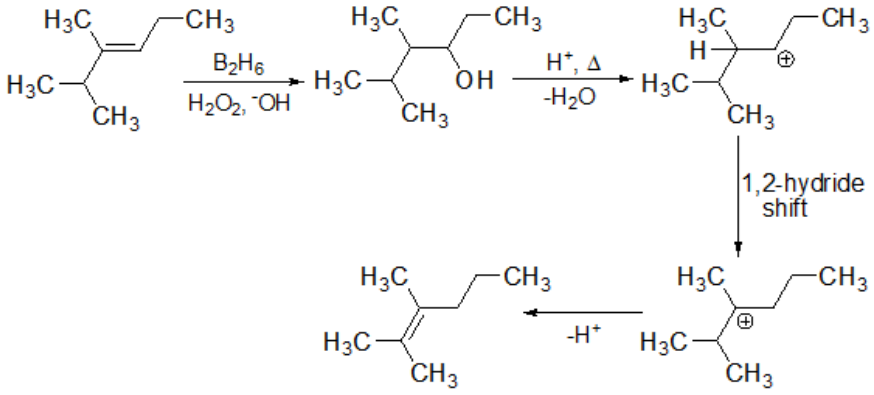


d.



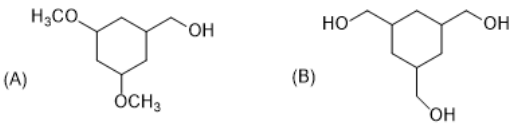
Answer: a

Solution:

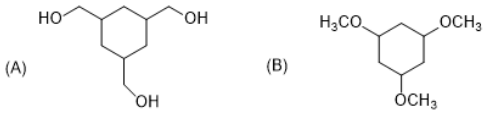


16. There are two compounds A and B of molecular formula $C_9H_{18}O_3$. A has higher boiling point than B. What are the possible structures of A and B?

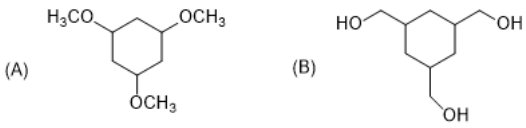
a.



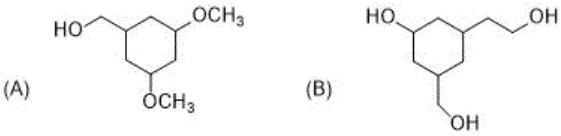
b.



c.



d.

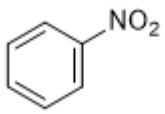


Answer: b

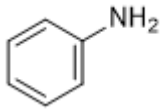
Solution: In option b compound A has extensive inter-molecular hydrogen bonding because of the 3 $-OH$ groups while in compound B there are $-OCH_3$ groups present and no inter-molecular hydrogen bonding is possible.

17. Kjeldahl method cannot be used for :

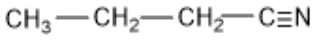
a.



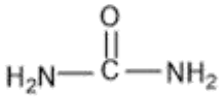
b.



c.



d.

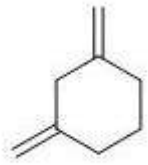


Answer: a

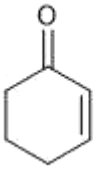
Solution: Kjeldahl method cannot be used for the estimation of nitrogen in the compounds in which nitrogen is involved in nitro, diazo groups or is present in the ring, as nitrogen atom can't be converted to ammonium sulphate under the reaction conditions.

18. A compound X adds 2 hydrogen molecules on hydrogenation. The compound X also gives 3-oxohexanedioic acid on oxidative ozonolysis. The compound 'X' is:

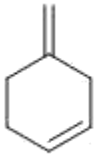
a.



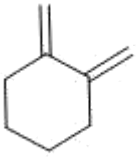
b.



c.

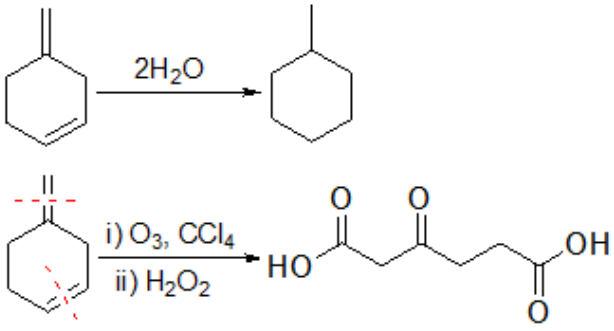


d.



Answer: c

Solution:



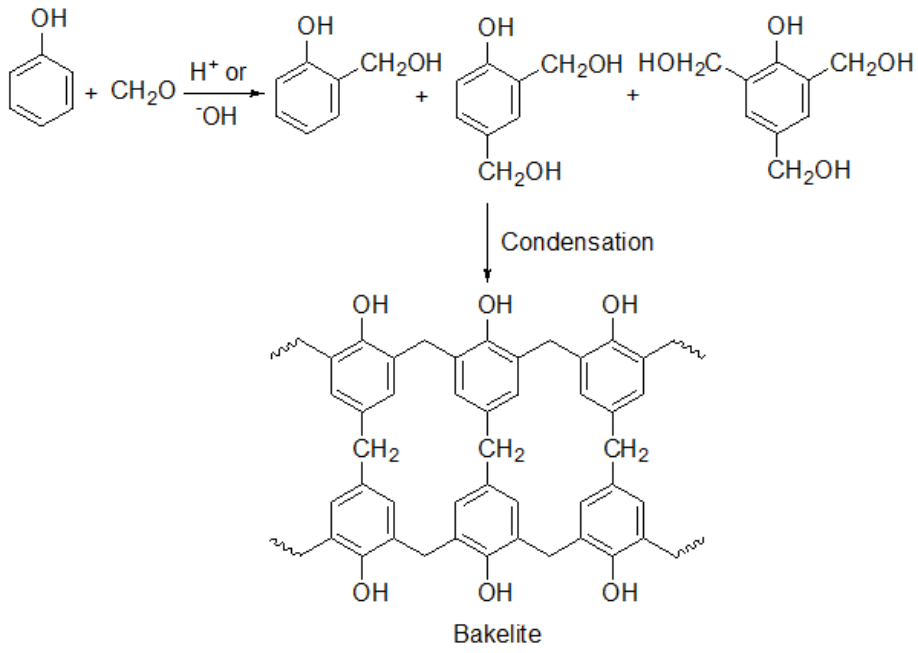
3-oxohexanedioic acid

19. Formation of Bakelite follows :

a. Electrophilic substitution followed by condensation.
b. Nucleophilic addition followed by dehydration.
c. Electrophilic addition followed by dehydration.
d. Hydration followed by condensation.

Answer: a

Solution: Bakelite is a condensation polymer of phenol and formaldehyde.

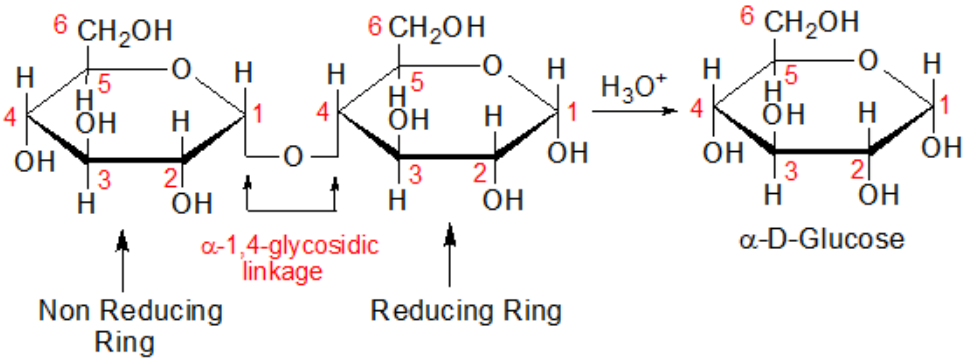


20. Products formed by hydrolysis of maltose are:

a. α-D-Glucose, α-D-Glucose
b. α-D-Glucose, β-D-Glucose
c. α-D-Galactose, β-D-Glucose
d. β-D-Galactose, α-D-Glucose

Answer: a

Solution:



Maltose is formed by the glycosidic linkage between C-1 of one α-D-Glucose unit to the C-4 of another α-D-Glucose.

21. Temperature of 4 moles of gas increases from 300 K to 500 K find 'C_v', if $\Delta U = 5000$ J.

Answer: 6.25

Solution:

$\Delta U = nC_v\Delta T$

$5000 = 4 \times Cv\ (500 - 300)$

$Cv = 6.25\ JK^{-1}\ mol^{-1}$

22. Given : $E^{o}_{Sn^{2+}/Sn}$ = -0.14 V ; $E^{o}_{Pb^{2+}/Pb}$ =-0.13 V. Determine $\frac{[Sn^{2+}]}{[Pb^{2+}]}$ at equilibrium
For the cell reaction $Sn|Sn^{2+}||Pb^{2+}|Pb$
Take $\frac{2.303RT}{F}$ =0.06 V, and $\sqrt[3]{10} = 2.154$

Answer: 2.15

Solution:

Anodic half: $Sn \rightarrow Sn^{2+} + 2e^{-}$

Cathodic half: $Pb^{2+} + 2e^{-} \rightarrow Pb$

Net reaction: $Sn + Pb^{2+} \rightarrow Pb + Sn^{2+}$

$E^{0}_{cell} = E^{0}_{cathode} - E^{0}_{anode}$

$E^{0}_{cell} = 0.01$ V

$E_{cell} = E^{0}_{cell} - \frac{0.06}{2}\log Q$

At equilibrium state $E_{cell} = 0$

So,

$0 = 0.01 - \frac{0.06}{2}\log\frac{[Sn^{2+}]}{[Pb^{2+}]}$

$0.01 = \frac{0.06}{2}\log\frac{[Sn^{2+}]}{[Pb^{2+}]}$

$\log\frac{[Sn^{2+}]}{[Pb^{2+}]} = \frac{1}{3}$

$\frac{[Sn^{2+}]}{[Pb^{2+}]} = 10^{\frac{1}{3}} = 2.154$

23. Given following reaction,
$NaClO_3 + Fe \rightarrow O_2 + FeO + NaCl$
In the above reaction 492 L of O_2 is obtained at 1 atm & 300 K temperature. Determine mass of $NaClO_3$ required (in kg). (R = 0.082 L atm mol^{-1} K^{-1})

Answer: 2.13

Solution:

Mol of $NaClO_3$ = mol of O_2

Mol of $O_2 = \frac{PV}{RT} = \frac{1\times492}{0.082\times300}$ = 20 mol

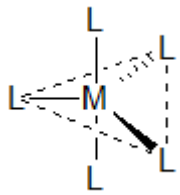
Molar mass of $NaClO_3$ is 106.5

So, mass = 20×106.5 = 2130 g = 2.13 Kg

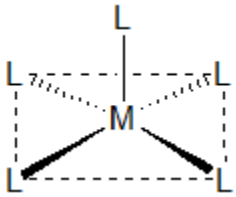
24. Complex $[ML_5]$ can exhibit trigonal bipyramidal and square pyramidal geometry. Determine total number of 180^0, 90^0 & 120^0 L-M-L bond angles

Answer: 20

Solution:



For trigonal bipyramidal geometry
Total number of 180^0 L-M-L bond angles = 1
Total number of 90^0 L-M-L bond angles = 6
Total number of 120^0 L-M-L bond angles = 3
Total = 10



For square pyramidal geometry
Total number of 180^0 L-M-L bond angles = 2
Total number of 90^0 L-M-L bond angles = 8
Total number of 120^0 L-M-L bond angles = 0
Total = 10
Total for both the structures = 20

25. How many atoms lie in the same plane in the major product (C)?

$$A \xrightarrow{\text{Cu tube}} B \xrightarrow{CH_3Cl(1\ eq.),\ AlCl_3} C$$

(Where A is the alkyne of lowest molecular mass).

Answer: 13

Solution: